**Systems Science Working Group (SSWG) Meeting**

**at INCOSE’s 2015 International Workshop (IW15)**

**in Torrance, California, USA, Jan 24-27, 2015**

***Systems Science Workshop Meeting Notes***

**Attendees:** See list of 34 attendees at the end of this report.

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**INTRODUCTION**

All presentations and handouts for this meeting can be found at this website:

* <https://sites.google.com/site/syssciwg2015iw15/sswg-at-iw15>

Information on previous meetings and workshops of the SSWG can be found at this location:

* <https://sites.google.com/site/syssciwg/home>

**MEETING NOTES**

# Saturday, January 24, 2015 sessions

## Introductions – James Martin

1. Introduction brief; goals; agenda; upcoming conferences and events
   1. Accomplishments; we need to develop and maintain a bibliography of our publications and panels
   2. ISSS 2016: John K: interested in sustainability; tentative theme: Crisis and Anticipation: Crossing the Hard/Soft Systems Divide [vice the NSF concept of coupling hard and soft, which still keeps them as separate and distinct]; hope to integrate the groups and threads more; have a Congress – 1+ day session coming up with policy statements for the government or society at large.

## General Systems TransDisciplinarity (GSTD) -- David Rousseau and Jennifer Wilby

1. Revisiting the 1950s goal of General Systems Theory or GST (Bertalanffy Circle…)
2. GST has been used for many concepts: discipline, paradigm, science, method, philosophy, world-view, problematics…
3. Defining a program for GSTD; using the notion of school within a discipline
4. Propose a taxonomy of terms and positioning of GST;
   1. Generic taxonomy: Discipline at the top; School is next level; then
   2. “GST” taxonomy: Systemology is discipline at the top; General Systemology is a school [Duane: What other potential schools? David: 2nd order cybernetics…]; …
   3. J Kineman: Worldview affects everything else; should be at the top?
   4. David/Jennifer: Agree that world view affects everything else; but this is not a hierarchy.
5. Defined mono-discipline, multidiscipline, cross-discipline, transdiscipline, general systems transdiscipline…
6. GSTD to GS worldview
   1. Set of attributes (of GSTD) as proposed by Bertalanffy Circle
   2. Set of worldview assumptions or tenets implied by the set of attributes (corresponding to Moderate Realism…)
   3. Discussion: John K: I have objections to the worldview assumptions, depending on how certain terms are defined. Janet: If there is agreement on the attributes proposed by Bertalanffy, why do we need the worldview assumptions (now)—we can develop those over time, right? David: we can make progress now with philosophers on the worldview assumptions
   4. Then this formulation leads to confirmation of a GST idea (in the taxonomy)
7. Maslow’s hierarchy of needs
8. Midgley’s three waves of systemic (scientific) inquiry: Hard sys, soft sys, critical sys
   1. That maps onto the Maslow hierarchy: the bottom 3 levels
9. John Kineman: Should also add autopoietic, self-organizing at the top of this hierarchy
10. They have identified some projects, based on the approach of considering pairs of taxonomy entities together (e.g., GST and systemics—analogous to atomic model and periodic table; GST and worldview—underlying unified ontology, manifested differently in different disciplines?; Ontology and Epistemology: Consilience—based on physics--physicalist reduction; or consciousness—mentalistic reduction; ontological pluralism; consilient pluralism)
11. They are doing this work and publishing the results.
12. They defined a research agenda for more studies. (Future website at [www.general-systemology.org](http://www.general-systemology.org).)

**<< Lunch >>**

## General Systems Theory (GST) – The relational view -- John Kineman

1. The west has rejected Eastern philosophy, perhaps to the benefit of technology;
2. Started with silence and an Eastern chant; intended to put us in touch with a larger reality
3. Threshold concepts—concepts that take us from no understanding to making something simple
4. Many of the quantum theory pioneers studied Eastern philosophy, which helped them see the theory or form the theory
5. Levels: Mechanistic >> Organic (Chinese; yin-yang) >> Dramatic (non-dual; participant and observer are not separate, not duality, but rather are one unity)
6. Holon: content vs. context
7. Participatory action research (PAR)/holon; integrates soft and hard, function and structure. 1-Observe, 2-Act, 3-Plan, 4-Reflect; 5-Whole? 1-Occurrence, 2-Action, 3-Design, 4-Origin; 5-Whole? Existence (Discovery) vs Behavior (Practice).
8. Discussion of relation vs interaction; west vs east; engineering vs general use.
9. Rosen modeling relation between natural system and formal system
10. Are yin and yang two separate things, or one whole? Are participant and observer? Are system and environment? Duane: Why either/or? The answer should be both are important views; for some purposes viewing as two interacting systems is useful, while for some other purposes viewing as one whole is useful. John: Agree.
11. Model-dependent reality?

## Introduction to Systems Processes Theory (SPT): Background -- Len Troncale

1. Basic concept--Unification: Look at a broad spectrum of natural systems, find common processes. Have found about 100 common processes across all these domains and scales of systems.
2. Anecdote: NSF director in the 1970s was interested in funding general systems research but did not have the political capital to do it; and NSF is still not doing it.
   1. [Note, however, that NSF is just now calling for research proposals on theory or science of SE. Several SSWG members attended a meeting at IW15 where this was discussed.]
3. Listed the processes; have contracted and expanded the list. James: Recommend putting the processes into a hierarchy. Len: There are several ways of grouping the processes: functional similarity; life cycle stage; dependencies; systems level.
4. Janet: Recommend distinguishing natural processes from human modeling or mathematical model. Len: So far we have Accepted, Structural, and Exotic (emerging) categorization of processes.
5. Len: The most important part of SPT is the linkage proposition between the processes.
6. James: Linkage is between processes. Recommend that you link structures with the processes that form them?
7. Len: So far have just identified a link. In the future, can identify what type of link. Many of the links are causal (Process A is a partial cause of Process B).
8. Janet: John Kineman’s general causal model could provide a foundation for Len’s specific linkages; John: and I need Len’s linkages to test the general model. Len’s processes and linkages are general abstractions across domains and scales. John’s causal model is the next higher level of abstraction.
9. Discussion of whether SPT and science answer How and/or Why.

## Criteria discussion -- Len Troncale

1. Discussed position of the criteria in the context of Rousseau’s taxonomy of General Systemology. [Processes belong in Description and Classification; linkage propositions belong in GST\*??]
2. Went through introductory packet for the workshop. Len had produced and provided initial criteria lists for each of the following:
   1. Criteria for a Scientific Theory [because we are defining systems science]
   2. Criteria for Isomorphy & Their Proof [because SPT is based on isomorphies]
   3. Criteria for A Process, Systems Process [because SPT isomorphs are processes]
   4. Criteria for Abstraction/De-abstraction [because must abstract to get isomorphs]
   5. Criteria for the SPT-GTS [because we are defining systems science]
3. John: Should add Worldview above Scientific Theory
4. Janet, others: Let’s start with criteria for **isomorphy**. This was agreed to.
5. Richard Martin: I suggest category theory be considered as a tool for isomorphy in this context
6. Discussed first criterion: Found in >1 phenomena in all five superdomains (physical, biological, social, human, symbolic). Remove symbolic? Why these domains?
7. James: This is trying to define the (100 or so) common ways that systems work
8. Len: That should be one of the criteria.
9. Janet: We should distinguish the working hypothesis [common process and structure patterns exist in nature] from the list of criteria and the list of processes?
10. Recommendation: Change the condition from “all five superdomains (…) ” to “multiple domains (e.g., …)”. This was agreed to.
11. Duane: There is a difference between candidate isomorphies and actual isomorphies. This list is criteria for actual isomorphies. We can define criteria for candidate isomorphies later. There was agreement with this distinction, and with proceeding first on criteria for actual isomorphy.

# Sunday January 25, 2015 Sessions

## Continuing discussion of Isomorphy Criteria -- Len Troncale

1. Duane: Recommend we leave at least 8 hours for the actual work on the sample processes.
2. Len: Agree; we will discuss criteria until 10 AM; then start on the deep dive process work.
3. Len: Any comments on the up front material in the package (definitions of process, etc.)
4. Several comments…
5. Discussion of isomorphism vs. homomorphism in mathematics: Which one is one-directional, which is bi-directional?
   1. [Duane – later: Isomorphism is bi-directional. Homomorphism is a map from one group (or other algebraic structure) to another with certain properties—e.g., map from group A to group B. Isomorphism is a bijective or invertible homomorphism; informally, an isomorphism exists between A and B if and only if every element of A is paired with one and only one element of B.]
6. John K: Suggestion: Instead of “isomorphies” or “processes” or “patterns”, how about something like “isomorphic pattern”?
   1. Response: Agree. We will use isomorphic pattern from this point on, instead of processes or isomorphies.
7. Bottom line on Criteria for Isomorphy: Substantial progress toward agreement was made and documented
   1. Agreed to change the name to “Isomorphic Pattern”
   2. Consolidated and simplified the first several criteria to a small agreed-upon set
   3. Revised criteria available at <https://sites.google.com/site/syssciwg2015iw15/sswg-at-iw15> in the file “03SPT session-edit\_Criteria Working Packet.docx

## Discussion of SPT Development Packet -- Len Troncale

1. General discussion of “Theory of everything” which Len said was the subtitle of his book.
   1. John: We are excluding unique or specific processes, including only general (patterns, in multiple contexts).
   2. David: SPT, and Bertalanffy, have the approach of observing similar processes or patterns, and they will point to the underlying principles that cause them; and those principles then explain how the systems work.
2. Development packet: Let’s pick one process (isomorphic pattern) from each category: accepted; structural; exotic.
3. David: I have a problem with the first accepted I.P., feedback. It is a component of a larger process, not a system function in itself.
   1. Duane: But we just redefined the criteria and the name: Name = isomorphic pattern, not process; criteria = it is an isomorphic pattern across multiple contexts; it does not need to be a complete system function, it can be a component process (or a composite process/function).
   2. David: Agree; that resolves my objection.
4. Group read Feedback material.
5. Comments: Overall feedback vs specific subtypes?
   1. Duane: Both are useful. Describe what is common to all, and also each subtype.
6. Discussed the description sections…
7. Richard M: Can a specific feedback example be “general feedback” or does it have to be a subtype? Duane: I think it will be a subtype.
8. Comment: How a Process and Identifying Features seem to be the same topic.
9. Comment: Identifying Functions (and Significance to Sustaining Systemness): These cannot be a complete set, because how the given pattern is used in larger functions or contexts is open ended. These are examples.
10. Len: On that idea: Look at AskNature.com: it has 2800 examples of biomimicry.
11. Jennifer: is there a difference in feedback in engineered systems from feedback in natural systems? Len: Good question to investigate.
12. Jennifer, Len: Are feedback pathologies in engineered systems different from those in natural systems?
13. Jennifer: Is there a threshold of feedback?
14. Janet: Feedback pathologies: Consider the System Archetypes (Meadows, Senge, etc.)
15. Len handed out a set of posters of systems processes (listed in his handout)
16. Duane: consider the information fields in standard pattern descriptions. Len/Luke: Send us links or references.
17. Jennifer: On Hierarchy: You need to include Wilson and White paper on hierarchy types

<< Lunch >>

## Formal Structural Systems: George Klir’s General System Theory as it relates to Schemas Theory – Kent Palmer

1. Part 1: Introduction and George Klir’s Theory
   1. Goal: To understand formal structural systems which is a type of general systems theory that combine three types of schema—pattern, form, system—in relation to other schemas.
   2. 10 schemas: facet, monad, pattern, form, system, meta-system, domain, world, kosmos, pluriverse.
   3. Meta-system: There is no word in English for this level. But there was an old English term: scape (as in landscape, mindscape…)
   4. These schemas are nested. They represent levels of abstraction or ontological levels, which differ from ontic levels, scales, composition levels of nature.
   5. Each of these is a view of space-time, a template for viewing the world
   6. Kent then mapped Klir’s theory to his schemas
   7. Klir concepts… System = (Things, Relations)
   8. Other schools of relational science : Rosen; Bateson (levels of learning)
   9. Lynn: cognitive psychologists have articulated levels of learning and development and cognition
   10. Substantive (traditional science emphasis) >> Relational (relational science emphasis) >> Continuous (Peirce focus??)
2. Part 2: Problem solving
   1. Problem solving is a relational view of the role of systems science; systems relate problems to solutions by schematizing both. Discussion: Is problem-solving perspective too anthropomorphic?
   2. Wicked problems…; paradox, absurdity, impossibility;
   3. Kent – revisiting why he is presenting this and where the presentation is going: We are looking at Len’s SPT as one proposed GST. It is helpful to our group to understand the context and other GST schools. Klir is attractive because of his mathematical approach. Mathematics, including category theory, have much to offer systems science and GST. Best category theory intro I have found: Basic Category Theory by Tom Leinster.
   4. Klir – Epistemological levels
   5. Peirce achieves generality via logic systems, continuity
   6. Kent achieves generality via ontology
   7. David, Kent: Discussed general versus universal; a general theory is not necessarily universal.
   8. Laws of form – G. Spencer Brown…
3. Part 3: Foundations, Meta-models, Carnap’s Ascension Forms
   1. Ken Lloyd Foundations of Systems Science: physical, conceptual, mental, mathematical worlds; similarities with Popper, Penrose, Carnap, Klir? Kent adds Carnap’s intersubjective world
   2. UML example of using meta-models: UML 1 was not coherent; Meta-Object Facility (MOF) provided coherence for UML 2.
   3. Category theory also illustrates meta-models?
   4. Kent proposes philosophical principles, schemas, foundational math categories, order hierarchies, laws of physics; these are connectors or interstices between the worlds (conceptual, mathematical, mental, intersubjective, physical)
   5. Carnap’s Ascension Forms…

# Monday January 26, 2015 Sessions

## Path to Systems Science-based Systems Engineering (SSBSE) – Janet and Michael Singer

1. NSF activity on defining a theory of SE: Workshop in Nov 2014; meeting at IW tomorrow
2. ISSS Aims – starting in 1950s with SGSR; aims of general systems theory
3. People got discouraged when it took so long; SS, natural science, social science, SE went their own ways
4. Historical development of associated science and engineering disciplines (from Hybertson 2009, based on Shaw and Finch…); multiple stages of development and linking of science and engineering
   1. SS and SE are at stage 3 of 5 stages [Problems and opportunities in practice stimulate development of science explaining observed behaviors]; we should not be discouraged that it seems to take so long to develop a real SS-based SE
5. Boulding – finding common constructs across fields; finding a gestalt…
6. Von Bertalanffy – general system theory;
   1. Recent: systems biology is active
   2. Bertalanffy has been getting more attention and getting more credit recently
   3. Three aspects: Systems science; systems technology; systems philosophy
7. Jack Ring – System Value Cycle – is consistent with Bertalanffy’s three aspects.
8. Len: This cyclic view also applies to development of science/SPT. Both can be seen as evolutionary views.
9. Janet: The above work can enable working toward SS-based SE. Steps—which can and should be pursued concurrently:
   1. Work toward unification of science from a systems perspective
   2. Mature systems science; not just natural phenomena but also science of the artificial—based on patterns of success and failure in both arenas
   3. Pursue development of GST, understood as an organized body of knowledge; a Guide to SysBoK
   4. Reflect the above items in SE Foundations – Part 2 of SEBoK, as well as the rest of SEBoK, SE Handbook, SE education, outreach, etc.
10. Len, Janet: More people are using systems terms – ST, SS, etc.—but not understanding the distinctions
11. Janet: We now understand that we need multiple views, not just one (e.g., feedback; networks; chaos; …). Discussed the distinction (and reconciliation?) between the need for multiple views of the world and a general underlying unity of what exists in the world.
12. James: Going back to the steps: Need to vet the unifying approaches before writing a guide to the overall SysBoK. Make the guide a separate (4th) step. Maybe work on the Guide first to show the gaps?
13. Janet: The transformation group is working on unification of SE practices. This is complementary.
14. James (and Janet): David’s taxonomy of Systemology may be a good starting point for the BoK Guide organization.
    1. David: We have the URL Systemology.org, and we plan to build this “map of the territory” on that site to show how various schools and ongoing work relate to each other (and provide links to the various works)
15. James: We should include David’s manifesto and (Janet’s?) intro in the new Section 2 of SEBoK?
16. Janet: Returning to the original aims of SGSR (ISSS):
    1. Len is working on Aim 1: isomorphy of concepts, laws, and models in various fields
    2. We are also very interested in Aim 4: unity of science – not just natural and social science but also artificial science.

## Continue discussing Isomorphic Patterns and Tenets of SPT – Len Troncale

1. Are there comments on the Guiding Tenets (SPT Development Context packet)?
   1. 2.11 StructurProcess – discussed
   2. 2.5 Axiomatic: Duane - Objection – science observations are contingent, not axiomatic. Len agreed to remove it (or change it to Fundamental?)
2. Comments on Data Categories for describing the Isomorphic Patterns
   1. Lynn: Recommend combining How an Isomorphy with Examples up front.
3. Len: Reviewed the posters on Feedback: Literature on feedback, number of articles… A large number, and it is still increasing
4. Hierarchy pattern
   1. We read the description/data categories of hierarchy
   2. Overview/definition: Objection to “heterogeneous”; Len removed this
   3. Duane proposed a definition as tree structure or repeating one to many structure
   4. Objections to this. There are tree structures that are not hierarchies, and hierarchies that are not trees.
   5. James: Distinction between hierarchy and the processes of generating it; we need to define features of both.
   6. There are different views or ways of representing the same hierarchy; our basic definition should not distinguish between views.
   7. Duane: I propose that hierarchy is a repeating one to many structure; that is the basic relation common to all hierarchies. Adding relations or constraints to this basic definition (composition, specialization, control, etc.) yields different types of hierarchy.
   8. There was disagreement with the one-to-many structure as the definition; but there was some agreement that there are different types of hierarchy.
   9. James: If we define the types, we can look at the process(es) that generate each type; and see if some of those processes are the same.
   10. Maybe add Consequences?
   11. [Conversation between Duane and Len at lunch: Duane: A key to understanding the isomorphic patterns is to define a clear model of the most general features—the ones common to all manifestations and types in various domains; and then describe the main types of the pattern and for each types its features. Len: OK. Can you define a model for a couple of the patterns we have looked at—feedback and hierarchy? Then I can get others (students?) to develop models for the other patterns in the same manner. Duane: Yes, I will take that action.]
   12. Richard Martin: Processes can also be hierarchical; this is a distinction between hierarchy types based on entity types (rather than based on relation types).
   13. Hierarchy pathology: Any comments? Richard E: Bi-directional control: A manager-employee situation where the employee manages the manager in a particular role or project.
   14. Discussion of decomposition and composition. Richard M: We need to be careful to define both elements of conjugates, such as decomposition/composition. Duane: From a generating process perspective, decomposition could be a different process from composition, and both processes could generate a hierarchy structure.
   15. Mike Watson: An organization hierarchy that changes in multiple environments. Where does that fit? Is it polymorphic? Janet: Polymorphism could be a separate isomorphic pattern; exists in materials science and software engineering (and organizations??)
5. Variation-Innovation isomorphic pattern
   1. We read the description of Variation
   2. Len showed his paper “Duality of stability and variation mechanisms in Biosystems
   3. Lynn: What is the difference between perturbation and variation? Perturbation can be temporary or permanent; perturbation may be a type of variation? That seems to fit for permanent perturbation, but not temporary, because variations are not seen as temporary? Janet: We impute perturbation in the context of variation. Disposition: Put perturbation in the Variation pattern as a concept for further analysis of how it fits.
   4. Lynn: Degree of variation; what is range of variation versus creating something totally new? Len defined variation as staying within a system, not creating a new system.
   5. Len: We can include anthropomorphic examples, and examples of natural and engineered systems, physical, social, …
   6. Joe Sweeney: I suggest we define variation as the set of inconsistent results, while perturbation is change to those inconsistent results. Janet: This belongs to the engineering domain. The use of inconsistent is also problematic.
   7. Joe: In the complex systems group people talk about intentionality. Complex systems are associated with intentionality?
   8. Joe: Is amorphous polymer a variation? They are unstructured, arbitrary structures
   9. Janet: Is Rhizome a variation? They are a dynamic growth pattern.
6. Cycles pattern
   1. We read the description
   2. Overview: Need more information here.
   3. Discussed “lifecycle”: Sometimes means life span or life history from birth to death. Is an ambiguous and misused term. Recommendation: Drop this term, and define more clearly the subtypes covered by this term.
   4. Richard M: Example: Monarch butterfly: The population goes through an annual cycle of 5 or 6 generations that collectively go from north to Mexico to southern US back to north. This illustrates Len’s point that a cycle can exist without being experienced by any single entity.
   5. Identifying Features:
   6. Is recursion cyclic? Janet: Iteration occurs in nature, but recursion is our projection or model of imputing structure to iteration.
   7. Both continuous and discrete?
   8. What about periodic systems? Are they all cyclic? Duane: Suggestion: Cyclic means coming back to the same or nearly the same point, while periodic simply means marks continuing along a line. Luke: Oscillating cycles return to the same point on the y axis but not on the x axis. This might be a step toward modeling cycles.
   9. Fractals? Also not in nature; we conceive fractals? Or maybe they are in nature?
   10. Hysteresis? We will add it for consideration
7. Cycles linkage propositions
   1. Question (James, others): “is a partial cause of” is unclear. Does it mean there also are other causes? [Yes] Is it necessary? Sufficient? [No] Influences? Can be a partial cause of? Len: We do not have enough knowledge to state the definitive relations of these linkage propositions.
   2. James: There are two types of partial causes: cause to come into existence, and cause to change. Can you distinguish these in the linkage propositions?
   3. Len: There are also many other types of partial causes.
   4. Len showed his list of relations (linkage proposition operators or association classes)
   5. Note that Warfield identified a set of general relations
   6. Kent P: Klir identifies resources, a framework, to deal with various general relations
   7. Len: I am not sure what the result of this discussion is. Can I still use “is a partial cause of”?

# Tuesday January 27, 2015 Sessions

## Structural Modeling – Joe Simpson

1. Presentation highlights
   1. Project overview: completed Definition, Documentation, and Development of Matrix manipulation code. Working on JavaScript versions for Web-based tooling.
   2. Definition has 3 activity areas: Basic Structural Modeling (the mathematics); Structural Integration Modeling (Prose and math); Interpretive Structural Modeling (problems in prose) that put the BSM and ISM into proper correspondence.
   3. Development has 4 components with BSM using Fundamental Mathematics and the Mathematics Engine, SIM using the Mathematics Engine and Application Software, and ISM using the Application Software and Team Processes for Applying Structural Methods (K. Dye works here).
   4. Abstract Relation Type is the elementary unit of description comprising a Formal Prose, Informal Prose, Graphs, and Math (including computer representation). Objective is to make the Prose Description, Graphic Representation and Mathematics & Computer Representations isomorphic.
      1. Richard E.: Are you talking about a concept maps type graphical representation of something more formal?
      2. Joe: Something more formal as shown on the next slide – Augmented Model Exchange Isomorphism, showing Prose, Directed Graph, Matrix (adjacency), Context, and Notes.
   5. Prose identify 3 kinds of relationship pairs as Prose Property Classes: Reflexive/Irreflexive; Symmetric/Asymmetric; and Transitive/Intransitive. These three pairs result in 27 possible property group combinations for relationship characterization that are possible among 3 kinds of structures: Dependent (Series). Independent (Parallel), and Interdependent (Coupled).
   6. Example of use of Symmetry Property Class to express Hierarchy, Network, and a combination of hierarchy and network.
      1. Richard M.: It would have been nice to have this graphic when we were discussing hierarchy yesterday. Did you listen to any of that discussion?
      2. Joe: Yes, my work is not at the same level of detail as Len’s and I was unsure of how to contribute.
      3. Richard M.: the criteria you identify should be useful for the process relationship discussion.
      4. Joe: One difficulty is that there is no consistent naming convention for these relationships and we are proposing to normalize them using the property classes.
   7. Brief discussion of total vs partial order implementation of code.
   8. Approach is synthesis drawn from several methodologies.
   9. Brief description of Web-based application architecture and test case preparation.
2. Joe: The reason to formalize the relationships is so that we can have repeatable measures with consistent results that are the basic requirements of science.
3. Richard: How can we use the structural relationship characterizations you identify to help clarify the linkage propositions that Len identifies?
4. Richard: Your work give us some ways to think about the variation among the isomorphic patterns when applies to situations.
5. Joe: When you identify the appropriate description then you get all of the three forms of isomorphic descriptions.
6. Richard E.: From an SE perspective, how do we create a hierarchical representation when here are multiple top levels, stakeholders, at each level.
7. Richard M.: You are inheriting requirements from multiple stakeholders. How would you address this issue from the work you are doing.
8. Joe: We have not really looked at this issue because the fundamental basic things are just not well enough defined.
9. Kevin: Warfield was working with groups answering binary questions and using inference. You are asking what happens if every person has their own matrix.
   1. Kevin: The first work on this was done in Japan concerning education but not to the extent you are seeking. I have done a bit of this regarding peer mediation but usually the votes are aggregated to get majority vote. You are asking about the edge of current work.
   2. At Ford the 300 requirements for a car door take a team of 6 people 3 months to review the 300 by 300 matrix.
   3. But the transitive, asymmetric, irreflexive relationships, which are functions, cover many real world relationships of interest to engineers.
   4. The problem is that the matrices are very sparse and doing it all is very tedious.
   5. The path of inquiry is different for every stakeholder and synchronizing responses is very difficult and no one is working in this area.
10. Richard E.: How would you apply your work to rub off the rough edges of the many different models stakeholders have.
11. Joe: You need to use MOEs and MOPs and integrate models from various experts under effective leadership.
12. Kevin: Need to remember that a 0 in the matrix does not need to mean No, it could be unknown.
13. Kevin: No one is working on decentralized structural models. May need to consider an agent-based simulation approach.

## Structural Modeling Testbed -- Kevin Dye

1. Presentation highlights
   1. Review of history of ISM and its success and obstacles for use.
      1. Unified Program Planning of Warfield and Sage initiated matrix use in system interaction analysis. First used at Lockheed and in urban planning.
      2. Became Quality Function Deployment as result of use in Japan to improve quality.
      3. Cost of doing evaluation became very high because of matrix processing cost.
      4. Relations of type of, part of, function of are a core systems modeling language that are easily represented by matrices.
      5. Can apply fuzzy logic to implementations of matrix relationships.
      6. No standard for all of the implementations created for this approach.
      7. Most ISM innovation is coming from the far-east.
      8. TATA’s ISM Center is the largest in the world.
   2. Identify objective of reduced cost, adaptation to many modeling formalisms, spur development of ISM algorithm, ensure quality of implementations.
      1. ISM reduces inquiry times by 70% - 85% as number of interactions grows because the matrices are very sparse.
      2. Problem was that work was kept proprietary and not published.
      3. 60 elements are a practical limit to ISM with current technology.
   3. Presented misadventures of basic and interpretive structural modeling – slide 4.
   4. Identified Testbed role for community of practice and community of interest – a touch point for collaboration on structural modeling.
      1. S. Umpelby thesis details 8 world views of system science resulting from divergence in system science communities and why system scientist and system practitioners do not get along with each other.
      2. Looking for why to deal with very fragmented community.
         1. Collaboration for both proprietary and open source initiatives
         2. Communities of specific ISM implementations by coordinating adaptations of methods
         3. Interface to modeling platforms
         4. Research outreach
         5. Troncale’s work is a nice structure to model as arrows and nodes then ISM might be useful.
   5. Identified Testbed components of Test Cases, Agreed Package of BSM Output, and Measures to be utilized.
   6. Discussed challenges to BSM/ISM use including scatter developers, prior users getting old or gone altogether, sporadic interest, and diversity of professional organizations that might be interested – ISSS, INCOSE, ASC.
   7. Discussed approach for making contacts and gathering support for Testbed approach.
2. Richard: How can we merge the need for a BSM/ISM Testbed with the work Len is doing on linkage propositions between isomorphic patterns of process? Len has a problem related to defining the structural relationships (both physical and logical) between process and Joe’s work to express John Warfield’s ideas concerning structural relations should apply somehow.
3. Kevin: Could also do the classic system dynamic archetypes of Senge and others.
4. Kevin: That might be possible and we might be able to leverage Klir’s reconstructability analysis to identify expected processes given a known process.
5. Kevin: Working at a distance with Len is difficult because of the lack of journal articles. He has a lot of notes that are not well organized for use by others.

## Maps or Itineraries? An SE Insight from Ancient Navigators -- Bill Schindel

1. Presentation highlights
   1. Basic observation is that there are two ways of getting from where you are to where you want to be – maps that show the relationships and itineraries that provide a set of steps to take.
   2. Ancient navigators used itineraries because they lacked the mental paradigms associated with later emergence of geographic maps like the Mercator projection of sphere onto a cylinder.
   3. System engineers must “navigate” a project “journey” and use “itineraries” in the form of processes and procedures to guide their work. But where is the “map”?
      1. Can use the notion of a system configuration space to characterize the map and then plot trajectories through that space as the set of system configuration as we ‘visit’ configurations during changes we make.
      2. We need to move toward stronger semantic models of systems to get beyond the current MBSE procedural orientation and fully characterize the transformations that occur.
      3. Need a stronger meta-model that captures interactions occurring within the system as well as elements within the system and their relationships.
      4. Suggest his S\* Model (Smallest Model of a System) conceptualization as a basis for such a model.
      5. The Elements occupy different dimensional subspaces of the model map for specific configurations with views of the map addressing stakeholder concerns.
      6. Well defined maps allow differential trajectory descriptions to compress dimensionality of the evolutionary path.
      7. Known trajectories enable agile innovation by clarifying how you got to where you are and which direction are you going – your current evolutionary path.
      8. Len: evolution of different development requirements in natural systems has a parallel in engineered systems. In developmental biology there are constraints imposed by past development that you cannot go beyond and you need to use things in a different way.
   4. Discussed INCOSE/OMG MBSE Patterns Challenge Team effort with S\* Patterns to enable adaptable systems.
   5. Modifications in configuration space must occur at the proper place in the trajectory.
   6. Agile methods require a deliverable every week or less to determine where you are in the configuration space.
   7. Discussed patterns as the DNA of systems – the repository of configurations that repeat.
      1. Cannot be agile if you do not accumulate experience.
      2. Living system are good at this
      3. Patterns are the way we describe accumulated experience.
         1. Patterns describe regularities across multiple instances.
         2. Configuration space trajectories accumulate experience in patterns
         3. Agile systems are more adaptable to different situations, but “mission envelopes” apply.
      4. Len: In natural systems the variation mechanism was born at the same time as the stability mechanism.
      5. Bill: Cannot make progress on innovation if there is no stability. Experience, variation and stability are essential roles for innovation.
      6. Len: In bio-systems experience and stability are the same. Variation is based on internal or external mechanisms to that.
      7. Bill: You said mechanisms and that is an important point. There is not one mechanism.
   8. Just as navigation has progressed from ancient use of itineraries to modern map based navigation, so too will SE progress from lists of procedural itineraries to model-based maps of system configurations that chronicle system evolution.
   9. Len: Metaphors are part and parcel of the way we think and real open up our minds sometimes. Your metaphor works well.
   10. Richard M.: This shifts us from the procedural to the structural.

## SPT Report Out – Len Troncale

1. Presentation highlights
   1. Changing the mnemonic from SPT to SP3T for System Processes, Patterns, and Pathologies Theory.
   2. Taking a clue from SE orientation toward performance measures we took a look at the criteria to apply to this work.
   3. Total of 13 hours across 2 major session segments utilizing 70 pages of prepared material.
   4. We had representation of both top down and bottom up theory formation.
   5. Significant revision to Criteria for Isomorphy and proving of isomorphy, associated tenets, and criteria for processes or system processes.
   6. Reviewed 25 standard or common “sysinformatic” information categories for system isomorphic patterns with some consolidation and clarification occurring.
   7. Discussed 4 proposed SIP’s: Feedback, Hierarchies, Variation, and Cycles.
   8. 21 specific recommendations for Feedback with highlights for:
      1. information feedback,
      2. need for graphical models,
      3. importance of ‘icon’ or ‘logo’ in communicating concept to audience,
      4. kinds of feedback,
      5. possible change to “regulatory mechanisms” rather than “feedback”,
      6. feedback in natural systems vs. feedback in engineered systems,
      7. possible threshold for feedback,
      8. can cyber-pathologies be identified and fixed, and if so by more than one solution,
   9. 37 specific recommendations for Hierarchies with highlights for:
      1. process itself is hierarchical,
      2. relationships between hierarchies and some networks as transforms of each other,
      3. use of tree or box or matrix to indicate or examine a hierarchy,
      4. kinds of branching or position of singletons,
      5. problem of getting past terms specific to users in one domain,
         1. compositional hierarchy
         2. taxonomic hierarchy
      6. getting acceptance of abstractions to general usage,
         1. some people cannot consider particulars
      7. distinction of process that creates hierarchy as distinct from the structural hierarchy it creates,
      8. sub-specialization vs. emergent hierarchies,
      9. importance of including information category of “types or taxons of” for every SIP,
      10. trends across hierarchy levels not disputed,
      11. developmental or embodied energies increase across hierarchy,
      12. possible new category for ‘range and depth of applicability’ and for ‘consequences of SIP’,
          1. different GST apply at different ranges of hierarchy
      13. need to resolve differences in use of term ‘decomposition’ w.r.t. hierarchies,
      14. distinction between differentiation and specialization hierarchies,
      15. challenge to the generalization that humans recognize structure first and then dynamics,
      16. more than one hierarchy acting on one entity,
          1. mixed and bidirectional control systems
   10. 15 recommendation for Variation/innovation with highlights for:
       1. considering definition phrase ‘range of inconsistent results from the same mechanism’ more like SE definition,
       2. relationship of variation/innovation to important SE concept of perturbations,
       3. distinction between instance of variation and permanence of variation,
       4. internal vs. external causes of variation,
       5. discriminate between variation innovation and states/phases – can or cannot return to original,
       6. creating opportunity for variation
       7. comparison of natural and ‘artificial’ sciences
   11. 14 specific recommendations for Cycles with highlights for:
       1. confusion in use of ‘lifecycle’ to resolve,
       2. recursion and iteration not the same,
       3. periodic systems as necessarily cyclical,
       4. relation of hysteresis to cycles,
       5. problem of ‘begins again at the same initiation point’ or not and individual vs. population level entities
   12. Considered some of 36 linkage propositions but much controversy and discussion over the operator “is a partial cause of”
   13. Total of 129 comments to further research or changes to make with vigorous discussion raising awareness and understanding
   14. Need to consider ‘composite’ or ‘compound’ processes
   15. Consensus still seems elusive
2. Richard M.: I received a comment in the hall after our second day to the effect that “you guys really did a great job discussing hard issues and clarifying positions and got something done.”
3. Len: We did a true workshop effort over the past 4 days. People were very disciplined in working together.
4. Steven: I thought it was very productive. The bar you set is very, very high.
5. Richard E.: Some of the things here are not ready for consensus, we do not know enough, and I am not at all discouraged by the work we did.
6. Len: This approach is consistent with LvB and the work of many of the founders of system science.
7. David R.: I think that while you may think we have different perspective on system theory but I think we are all seeking the same thing and that efforts like this will help us to come together in pursuit of a general systems theory. We are really trying to sort thing out without a competitive attitude.
8. Janet: We are the exemplars as a community working together. The influence of SE’s is very helpful to system sciences in focusing our effort on common goals of use to society.
9. Janet: I talked with people that came in and said these are the same topics of other groups but you are actually accomplishing something. We are really a multi-disciplinary team.
10. Richard M.: Move to something that became obvious to me earlier today when Kevin was talking about a Testbed. Joe’s presentation was about the relationships between entities that are similar to the discussion we had about linkage propositions. We can apply Joe’s tool to the isomorphic patterns and the linkage between them to help clarify those linkages and test Joe’s tool as a testbed.
11. Kevin: I think you have stated it correctly. Len talked about diagrams of his processes and behind those diagrams are ways to add mathematical patterns.
12. Len: Suggest that Richard send us the contact information and we can exchange foundation documents.
13. Richard: I can send Len the wave files from this morning to bring him up to speed.
14. Janet: One thing you will find is that instead of arguing about the words ‘a partial process’ you can use the technology to clarify the relationships between processes.
15. Len: my caveat is that I was going to drop out of all contact for a year while I write the book.
16. Richard: You just need to make sure we are not doing something wrong, Luke can carry the load.
17. Richard: Now we take a picture to close the workshop!

# IW15 SSWG Attendees

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